INEEL REMEDIAL ACTION MANAGEMENT SYSTEM

Michael V. Carpenter,
Lockheed Martin Idaho Technologies Company,
Idaho National Engineering and Environmental Laboratory, P.O. Box 1625, MS 3710 Idaho Falls, Idaho 83415
(208) 526-8467

Robert J. Gehrke,
Lockheed Martin Idaho Technologies Company,
Idaho National Engineering Environmental Laboratory, P.O. Box 1625, MS 2114 Idaho Falls, Idaho 83415
(208) 526-4155

Lyle G. Roybal,
Lockheed Martin Idaho Technologies Company,
Idaho National Engineering Environmental Laboratory, P.O. Box 1625, MS 3840 Idaho Falls, Idaho 83415
(208) 526-5744

ABSTRACT

Since 1992, the Idaho Engineering and Environmental Laboratory (INEEL), funded by the Department of Energy's (DOE) EM-50 Program, has developed an *in situ* radioactive and hazardous waste monitoring and data management system that can be applied during radioactive and hazardous waste cleanup operations.[1] This system is called the *Remedial Action Management System* (RAMS). To fully test RAMS, all pre-cursor elements of the system were subjected to actual field deployments at various DOE-complex sites. The Warthog platform and an early prototype of it, the Dig-face Trolley, were fitted with a variety of radiation sensors and used in various combinations at Mound Laboratory and Savannah River Site[a,2] (SRS) between 1995 and 1997.

The Warthog system, which consists of sensors deployed from a commercial excavator, is considered to be commercially viable after successfully deploying radiation sensors from it in August 1997 at the OU4 Miami-Erie Canal (MEC) plutonium (Pu-238) removal action, in Miamisburg, Ohio. The *Real-Time Data Management System* (RTMS) prototype was integrated with Warthog system, providing command-and-control for the Warthog at MEC as well as at earlier deployments with the Dig-face Trolley at SRS and Mound Laboratory[3]. Currently, through the sponsorship by the DOE-Accelerated Site Technology Deployment (ASTD) program, the RTMS is being integrated with *in situ* monitoring hardware at Fernald (DOE) Laboratory near Cincinnati, Ohio.

The Fernald Environmental Management Project (FEMP) is utilizing RAMS to integrate real-time data acquisition, system positioning, contamination mapping, and data archiving functions related to *in situ* data collection. RTMS makes this information about the remediation process instantly available to site managers in the field. RAMS software, hardware and radiation sensor technology is included for out-year applications of the Fernald soils remediation program.

I. INTRODUCTION

During environmental remediation projects, waste disposal, treatment, and field sampling functions account for a high percentage of the total cleanup costs. Consequently, an efficient on-site decision making process is key to reducing these costs by utilizing real-time information collected throughout the remediation process. It is also critical that high quality characterization data be immediately available for use in assessing whether or not certain aspects of a remediation should be undertaken. Support for *in situ* radiation, chemical, and other measurement technologies must continue so that their use throughout the DOE-complex can reduce cleanup costs and worker exposure to contamination. This paper, and the associated poster presentation, provides an overview of RAMS, its features, and the value of systematic utilization of those features during real-time *in situ* monitoring and characterization activities.

II. BACKGROUND

The RAMS concept is a refinement of earlier prototype hardware, software and sensors; where the interplay between these system elements can be

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[a] Ford Building Waste Unit site contaminated with low levels of ^{137}Cs

manipulated to produce an optimal *in situ* measurement and data management system. The various components that physically embody the RAMS concept were realized as the building blocks that support a comprehensive management approach to remediation activities that require high quality field screening results. Testing during earlier development and then during subsequent deployment phases has resulted in the confidence that each element of RAMS can now be used at virtually any site, providing remote-sensing applications and real-time data management of remediation field screening activities. Depending on the actual conditions and requirements at a particular site, each element of RAMS can be modified, adapted, and used in combination with other elements of RAMS, or integrated with on-site hardware.

A. Real-Time Data Management System (RTMS)

The INEEL RTMS is a computer based program application that is used to integrate many types of hardware, software, sensor, positioning, and data analysis functions. The RTMS is used, for example, to integrate field deployed sodium iodide (NaI) and high purity germanium (HPGe) gamma sensors and real-time data acquisition functions for hardware and data analysis software currently in use at Fernald.

At Fernald, the RTMS integrates functions of positioning, data display and processing, transfer, and archiving of *in situ* data collected during remediation activities at the site. The RTMS consolidates and automates many costly *in situ* measurement related functions formerly performed separately and manually. The system is designed to enhance large-area field screening functions currently performed by the Radiation Tracking System (RTRAK) and the HPGe system hardware currently in use at Fernald for soil contamination waste disposition decisions and clean soil pre-certification. These systems are shown in Figure 1.

The system provides a method for monitoring excavation sites in order to improve the safety and efficiency of hazardous waste retrieval and other excavation activities. The system is designed to derive utility from three main system functions: adaptable field hardware, real-time data acquisition and management system, and sensors. Dictated by variations in site conditions, available support, contaminants, and cleanup criteria, the RTMS uses flexibility as the core feature of the system concept. Figure 2 shows several applications that can be performed using the system.

B. Warthog

The Warthog is a specialized platform to which a variety of radiation sensors can be attached and used to investigate areas of contamination by methodically scanning the surface during data collection. The platform possesses automated functions that enhance data quality by maintaining constant vertical platform position during scanning operation. This is accomplished by using mechanical dampeners on each of the platform's axis of travel. A terrain following system maintains a nearly-constant, vertical, sensor offset from the surface under investigation. The Warthog platform can be attached to the arm of most commercially available tracked excavators (e.g. John Deere 790 ELC) as shown in Figure 3. With a sensor attached to the base of the sensor mount plate, the platform scans an excavated surface, acquiring data in a precise pattern, logging the exact position of each data point. This sequence is repeated for each successive vertical "slice" of the excavation until the contaminant activity level falls below cleanup requirements. Information generated by the Warthog system via the RTMS, is converted real-time into contamination maps used by site managers to make critical decisions regarding the next step in the cleanup process. The Warthog is an information system used by waste site managers to improve the process of hazardous and radioactive waste characterization and to protect site workers (Figure 5).

Insufficient information about waste retrieval heightens the level of risk to worker safety and poses potential downstream waste and storage problems by unnecessary mixing and spreading of hazardous materials. The Warthog monitors ongoing changes in "hot-spot" waste site conditions to compensate for the inherent lack of knowledge of conditions during an excavation. By continually updating information at the dig-face as waste retrieval proceeds, the Warthog system provides waste site managers with a rapid means to make well-informed decisions throughout the remediation process. Use of the Warthog can dramatically improve the decision-making process by reducing the dependence on hand-collected field samples, reducing waste volumes by delineating between clean and contaminated soil, removing a sizable portion of health risk issues by reducing personnel exposure to unknown hazards, and allowing on-site managers to adjust and act quickly to changing conditions during the remediation.

The Warthog is based on the concept of dig-face characterization[1] (DFC) which offers an alternative approach of excavating a site in small, controlled vertical lifts and rapidly mapping each new surface completely to precisely characterize changing conditions.

C. Sensors

Systematic monitoring has been shown to be particularly valuable during excavation of hazardous waste sites. Many types of sensors are commercially available that are capable of detecting a wide range of radioactive and hazardous materials that reside at many former "cold-war" production facilities. Historically, these commercial field sensors have been used to indicate the presence of one or more contaminants-of-concern and to crudely determine its activity and distribution. Even now, these sensors are typically handheld and are to a large extent, independent of a formalized real-time *in situ* measurement-management system. The RAMS provides that formal accounting system.

RAMS sensor technology focuses primarily on radioactive contamination that is pervasive, in one form or another, throughout the DOE-lab complex[b]. As part of the RAMS approach, sensors developed at the INEEL are coupled with deployment platforms such as the Warthog, and linked with the RTMS to provide a comprehensive monitoring system that replaces a slow, expensive and potentially hazardous hand-collection field-screening process[4]. This new approach also dramatically introduces a more realistic method of analyzing data. Figure 4 shows a side-by-side comparison of hand collected field-screening samples (pCi/g) with *in situ* measurements (counts per second) collected using the Warthog/RTMS/CaF_2-sensor combination at MEC. This comparison indicates that a great deal of inference between 30 hand-collected sample locations is required to complete a "map" and to accurately assess the true distribution of contamination[5]. The resolution of detail of the same area is dramatically improved when several thousand measurements are used to analyze it. Two questions that should be considered here by the decision making process: (1) *given these two maps of the same area of investigation, which one should be used to determine the next step in the cleanup process and (2) what is at issue when considering all factors?*

The INEEL RAMS project has developed and field-tested two radiation sensors, an array of six CaF_2 detectors, and a plastic scintillator. Using the Warthog and a hand-propelled cart, the CaF_2 successfully detected and mapped the distribution of Pu-238 during a removal action at MEC. Maps derived from scanning the excavations with the CaF_2 and the plastic scintillator sensors (Figure 5) showed activity above cleanup levels within the excavation. Also deployed from the Warthog, a collimated Ge-spectrometer (non-scanning measurements only) provided field hotspot analysis in areas of interest. The RAMS Warthog can place virtually any field sensor over hot spots with great precision to obtain confirmation measurements within the area of interest like those shown in Figures 4 and 5.

III. CONCLUSIONS

This project, thus far, has shown that rapidly and precisely collected *in situ* measurements that can be utilized immediately, is preferable to conventional time and labor-intensive field screening techniques. One of the most important features of system is that its use can lower on-site health risks by reducing human exposure to contamination through reduction, and in some cases, elimination of hand samples during the field sampling process.

Total-area field screening versus representative, hand-collected lab-analyzed sampling, will ultimately reduce the uncertainty that has driven current, but changing cleanup policies. The RAMS approach also suggests that operational costs can be reduced during environmental restoration activities by wise use of technology that reduces the volume of material disposed of by effectively delineating clean from contaminated material and by ensuring that the site will not require a later reassessment due to unexpected discovery of missed contamination.

Use of RAMS has shown that it provides a balanced, realistic, and flexible approach to the management of remedial actions by offering several system applications to variable waste site conditions. The INEEL *tool-box* approach has demonstrated that it can respond to variations in physical site conditions, and site resources and cleanup requirements that would effectively limit or eliminate many other systems or processes that rely on narrow operating parameters (i.e. systems that only function using only a certain type of sensor, can detect only a narrow selection of contaminants, or can operate only in gentle, open, terrain).

We believe that RAMS has begun to have a positive influence on the environmental restoration

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b ^{137}Cs, thorium, plutonium, ^{60}Co, and Uranium are common examples of radioactive contamination at DOE sites.

industry along with those organizations that have stepped forward by using new techniques to improve results during cleanup activities. The DOE has moved this process forward by promoting the use of these technology resources throughout the DOE complex as a means to effectively address this large cleanup task.

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(1)

(2)

Figure 1. *Photos show large-area field screening system hardware currently in use at FEMP for soil contamination waste disposition decisions and clean soil pre-certification: (1)) the HPGe and (2 Radiation Tracking Systems (RTRAK).*

Figure 2. *Photos show several applications of RTMS shown left to right: FEMP RTRAK, INEEL hand-propelled plastic scintillator cart, RTMS work station, INEEL Warthog with CaF2 radiation sensor attached and FEMP HPGe soil monitoring system.*

Figure 3. *Photo shows the Warthog Platform in operation at the Miami-Erie Canal during cleanup activities to remove Pu-238 contaminated soil in August 1997.*

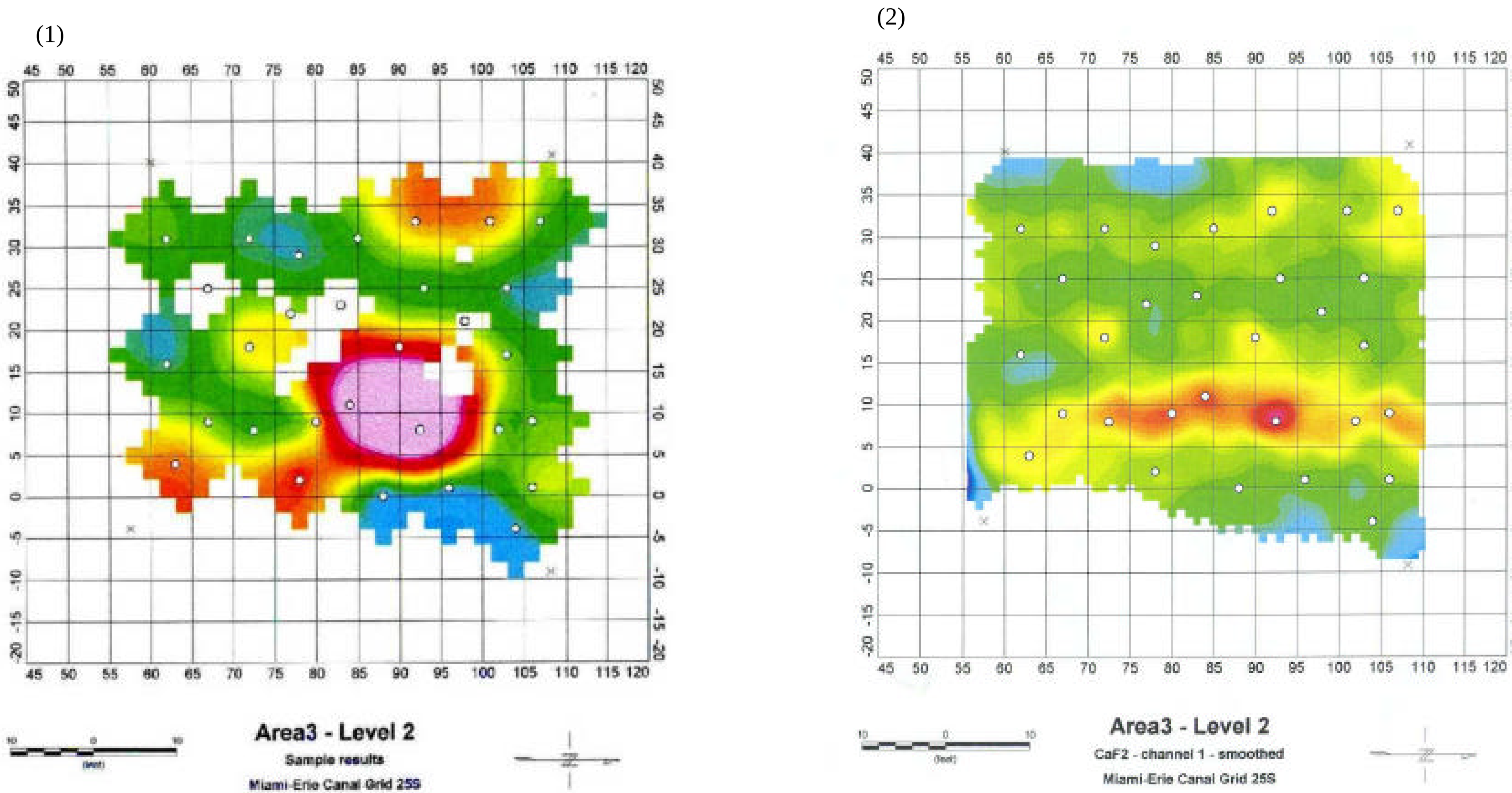

Figure 4. *Side by side comparison shows contoured Pu-238 data from 1) 30 hand-collected samples taking 2 hours to collect with 2) 21,916 in situ measurements collected in 91 minutes in the same location. The color gradation in both plots represent activity level as a function of the count rate. Hand-collected sample points in panel (1) are superimposed on panel(2) plot. It should be noted that under normal sampling procedure for this site, a total of four hand samples would be collected-not the 30 taken specifically for this comparison. The area of investigation is approximately 672m^2.*

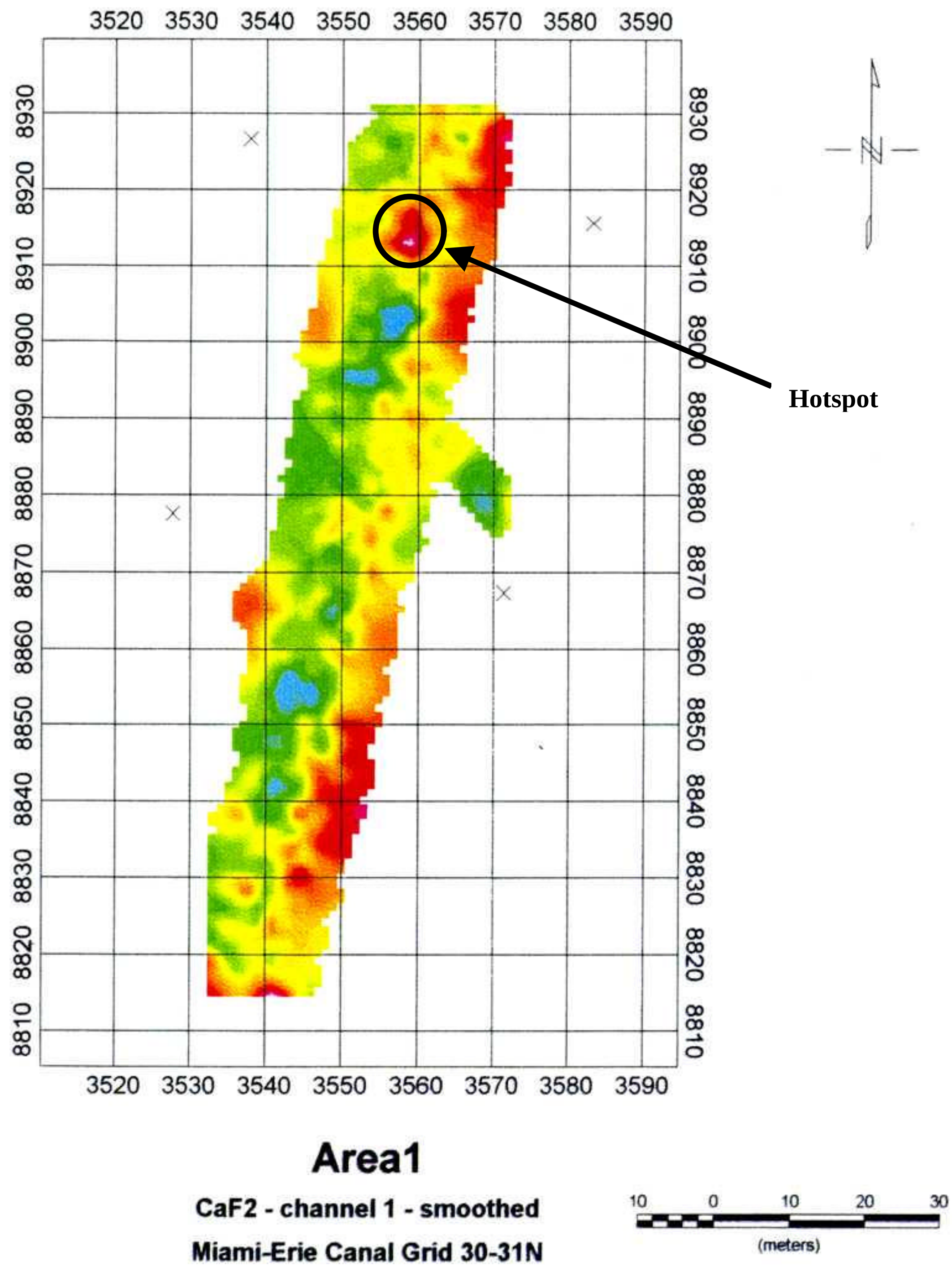

Figure 5. *Contour map shows example of hot spot detection using Pu-238 distribution maps derived from scanning the excavation with INEEL developed* CaF_2 *sensor deployed from the Warthog platform. This hotspot (circled) had activity measured above cleanup criteria at this site.*